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METHOD FOR ELIMINATING PAPER DEFECTS IN CONTINUOUS PAPER PRODUCTION
[Verfahren zur Beseitigung von Papierfehlern bei der kontinuierlichen Papierherstellung]

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(57)

A method of eliminating paper defects in continuous paper production in which the time lost to defect elimination is reduced has the following steps:

a) identification and localization of the paper defect by means of a sensor directed on the running paper web;

b) registration or calculation of the paper-web speed between the sensor and a station for defect elimination spatially following the sensor;

c) calculation of the time at which the section of web containing the defect will arrive at the station for defect elimination, based on the speed of the paper web;

d) reduction of the web-section speed to a speed less than normal or to zero even before the web section with the paper defect arrives at the station for defect elimination;

e) automatic elimination of the paper defect at the station for defect elimination; and

f) increasing the speed of the web section to the normal speed.

Description

This invention relates to a method of eliminating paper defects in continuous paper production. Continuously operating paper machines comprise the following stations: material intake, screen section, press section, drying section, dry-smoothing section, and winding section. At the material intake section, the aqueous material suspension is evenly distributed over the width of the web, to provide optimum sheet formation. In the subsequent screen section, the sheet of paper per se is formed in a filtration process. The individual paper fibers are fixed in their final position in a wet fiber sheet. Then, in the press section, the excess water is removed from the paper

fiber sheet by means of pressure. For this purpose, the paper web moves through a plurality of successively arranged presses. Following subsequent drying, the paper web is smoothed, typically by a smoothing unit consisting of two rollers which, in addition to smoothing, also compresses the paper, thereby influencing the paper thickness. Finally, the paper web is rolled up on a drum.

Defects can be produced in the paper web during the above-mentioned production process. These defects may be holes or tears along the long edges of the paper web or they may be dark or light spots on the paper web. Moreover, undesired material lumps or creases in the running paper web may be caused during production. These defects generally do not disrupt further transport of the paper web within the paper machine. At subsequent processing stations, however, such as in a downstream coating machine or in a printing press, the paper web may tear or even be completely ripped apart at the defective places. As a result, paper defect of this type must be eliminated even before the paper web reaches a subsequent processing stage.

In the past, paper defects have been eliminated manually in that, at places where a defect has been detected in the paper web being monitored for defects, a mark was placed on the web. This was done with the help of sensors (c.f. "Defect Detection and On-Line Analysis of Coated Papers" in: Appita Journal, Vol. 44, No. 5, pp. 30 and 306). In a subsequent station, when the paper web section marked in this way approached, the paper web was slowed to a crawl, so that an operator

could attach a sticker to the defective spot. Depending on the type of defect, the operator could remove the entire defective paper web section and attach an adhesive splice across the entire width of the paper web. This type of defect elimination is time-consuming, since the speed of the paper roll and, thus, of the entire paper web, must come to a crawl or even to a standstill, in order for the defective area to be eliminated. However, even this time consuming and, thus, costly elimination process is insufficient to eliminate paper defects as a cause of tears in subsequent processing steps.

DE 691 21 545 T2 describes a device for monitoring a moving material web. Monitoring occurs by means of a plurality of video cameras directed toward the material web, whereby additional illumination devices are provided in order to brightly illuminate the surface of the material web currently captured by the video camera. At least one video camera is directed toward the top side and one toward the bottom side of the material web. Additional cameras serve as optical sensing devices for the edges of the material web. This publication describes mainly technical details for evaluating the image signals produced by the video cameras. There are no references to eliminating the defects detected in this way.

The object of the present invention is to create a method with which the time lost during paper production due to the elimination of defects in the paper web can be reduced.

To achieve this, a method of eliminating paper defects in continuous paper production is proposed that contains the following steps:

a) identification and localization of the paper defect by means of a sensor directed on the running paper web;

b) registration or calculation of the paper-web speed between the sensor and a station for defect elimination spatially following the sensor;

c) calculation of the time at which the section of web containing the defect will arrive at the station for defect elimination, based on the speed of the paper web;

d) reduction of the web-section speed to a speed less than normal or to zero even before the web section with the paper defect arrives at the station for defect elimination;

e) automatic elimination of the paper defect at the station for defect elimination; and

f) increasing the speed of the web section to the normal speed.

Thus, according to the present invention paper defects are detected and localized solely by conventional means, namely using suitable sensors, whose detection elements are directed toward the running paper web. Unlike with the previously used means, however, the speed of the paper web between the sensor and a station for defect elimination spatially following the sensor is detected or calculated. Based on this speed, the point in time is calculated at which the web

section with the paper defect will arrive at the station for defect elimination, whereby the speed of the web section is reduced below the normal speed or even reduced to zero even before arrival. Then, using suitable devices at the station, the paper defect is automatically eliminated at the time calculated on the basis of the speed of the paper web,. Afterward, the speed of the web section is again increased to its normal value.

Unlike the case of the known manual defect elimination, it is not necessary to reduce the speed of the paper web carefully and by hand to the value required for eliminating defects. Instead, based on the information obtained by assessment of the detection signal, a decision is made internally within the system as to what speed the web section must have in the subsequent station for defect elimination, in order to reliably eliminate the paper defect. For this purpose, the sensor can be designed in such a way that it not only detects and localizes the paper defect, but also determines its character, e.g., the type and contour of the paper defect and its location relative to the width of the paper web. All this information can be utilized and evaluated within the system, in order to adjust the speed of the web section within the station to the value required for eliminating the defect. In this way, the time lost to the elimination of defects in the paper web during paper production can be reduced to the required minimum.

In one design of the process, it is proposed that, before reaching the sensor, the paper web run through an additional sensor

and that the additional sensor implement a preliminary or approximate determination of the paper defect, while the sensor is aimed at additional determination of the characteristics of the paper defect, e.g., its type and shape. In this way it is possible to run the paper web and, thus, the paper machine in normal operation at a very high speed, since the additional sensor is used exclusively for recognizing and preliminarily localizing a defect. Consequently, the measurement characteristics of this sensor are designed for quick detection and less for a detailed detection. Details are then detected by the sensor located before the station for defect elimination. Details of this kind include the type of paper defect, its shape, and the location of the paper defect along the width of the paper web.

Preferably, the time at which the web section with the predetected paper defect arrives at the sensor is calculated, based on the speed of the paper web on its way to the sensor.

In another configuration of the method, it is proposed that the speed of the web section with the paper defect be reduced to a value less than the normal speed even before the web section arrives at the sensor. Moreover, the already reduced speed can be reduced to an even lower value or to zero immediately before the web section reaches the station for defect elimination.

This invention also proposes elimination of the paper defect by covering the defective space with a quick-hardening fluid, thereby forming a flat covering. In a first variant, the fluid can be applied

by single or double-sided spraying to the defective area. In a second variant, the fluid can be applied to the defective area by rollers.

A quick-hardening UV lacquer, in particular, is a suitable fluid.

The method is suitable for both on-line and off-line paper production. In the former case, station, sensor, and additional sensor are arranged along a continuous paper web, so that paper defects are automatically eliminated in the paper machine at full paper-web speed, while in the latter case the additional sensor is placed on a paper machine and the station and sensor are arranged along a take-up roll or preroller placed after the paper machine. The take-up roll or preroller is the connecting element between the paper machine and the coating machine.

Additional features and advantages will be explained below with the help of an exemplary embodiment. Here, reference is made to the accompanying drawing showing a side view of a preroller, which is arranged between the paper machine and the coating machine within the production process.

The right side of the drawing shows drum **1**, on which the paper web wound up at the end of the paper machine is located. This paper web can have paper defects in various places. These paper defects are detected in the paper machine placed before it, whereby the location of the paper defect along the length of the paper web wound onto the drum is stored internally in a control unit. After drum **1** has been mounted on the preroller, the system already "knows" where along the

length of the wound paper the web defects are located. Alternatively, it is also possible to provide drum 1 with a built-in memory element that contains the corresponding positional data on the paper defect, i.e., an electronic chip arranged on the drum.

In the preroller, the paper web is pulled off of drum **1** and then conveyed over a first guide roller **2** and a second guide roller **3**. The paper web itself is indicated on the drawing by the reference number **4**.

Between drum **1** and guide roller **2** there is a sensor **5**, whose detection characteristics differ from those of the additional sensor, which is integrated into the preceding paper machine. While the additional sensor is aimed only at detecting paper defects even a high web speeds and to determine their location at least roughly, sensor **5** attached to the preroller is designed to determine the previously detected paper defect, with regard to its precise nature as well as the size and extent of the paper defect. Moreover, sensitivity to additional properties of the paper defect can also be provided, e.g., the detection of light/dark shading or of blisters and creases. Based on the measured values from sensor **5**, the system then decides internally the extent and manner in which a defect should be eliminated.

Since the rough location of the paper defect is already known, based on the measured results of the additional sensor, the speed of the web section with the paper defect can be reduced to a value less

than the normal speed even before this web section arrives at sensor **5**. This has the advantage that sensor **5** is prepared for the arrival and the approximate location by defect signals and can begin the detailed determination of the defect without delay.

Assuming that the paper web enters the preroller from the paper machine immediately and without interruption, the time at which the web section with the predetected paper defect reaches sensor **5** can also be calculated from the speed of the paper web on its way from the additional sensor to sensor **5**.

The paper defect is eliminated in station **6**, which in this exemplary embodiment is located between guide roller **2** and guide roller **3**. A spray head **7** is arranged there and is aimed at paper web **4**. It sprays a quick-hardening UV lacquer onto the defective area. Alternatively, the fluid may also be applied by rollers. As seen in the drawing, it may be applied to one side or two. An alternative to the quick-drying UV lacquer is the use of a suitable plastic adhesive. The important point is that the fluid per se is capable of covering the defective area in a manner that is flat and forms a film, thereby protecting the paper in the region of paper defect during additional processing, e.g., in a coating machine or a printing press. It should be easy to separate the material that is used during the repulping process, e.g. in reject processing or recycling.

The fluid is applied at station 6 automatically, i.e., without human intervention. For this purpose, the precise time must be known

at which the web section with the paper defect will reach the working area of spray heads **7**. This is determined by the speed at which the paper web and, thus, the defective web section move from the sensor to spray head **7**. Consequently, the speed of the paper web between sensor **5** and station **6**, which spatially follows sensor **5**, must be detected or calculated and, based on the determined speed, the precise point in time at which the web section with the paper defect will arrive at station **6** is calculated. Moreover, the control unit for spray head **7** takes into account the measurement made by sensor **5**, i.e., spray head **7** does not operate across the entire width of the paper web in all cases, but only in the region that has been found to be defective in the longitudinal direction and across the width of the web. Consequently, spray head **7** is advantageously made of a plurality of individual spray nozzles that are arranged across the width of the paper web and are individually controllable.

Even before the web section with the paper defect arrives at station **6** the speed of the paper web is reduced to a value less than the normal speed or to zero. After station **6** has been passed and the drying process may be considered complete, the speed of the paper web is raised once again to its normal value.

The drawing shows the method for off-line application, i.e., the additional sensor is in the paper machine and station **6** and sensor **5** are arranged in the preroller. On-line application of the method is also possible, however, whereby station, sensor, and additional sensor

are located along a continuous paper web, e.g., in a combine paper and coating machine.

The sensor operate optically over the entire width of the paper web. Infrared photodetectors or CCD line cameras may be used.

List of reference numerals

1 drum

2 guide roller

3 guide roller

4 paper web

5 sensor

6 station

7 spray head

Claims

1. A method of eliminating paper defects in continuous paper production having the following steps:

a) identification and localization of the paper defect by means of a sensor (5) directed on the running paper web (4);

b) registration or calculation of the speed of paper web (4) between sensor (5) and a station (6) for defect elimination spatially following sensor (5);

c) calculation of the time at which the section of web containing the defect will arrive at station (6) for defect elimination, based on the speed of paper web (4);

d) reduction of the web-section speed to a speed less than normal or to zero even before the web section with the paper defect arrives at station (6) for defect elimination;

e) automatic elimination of the paper defect at station (6) for defect elimination; and

f) increasing the speed of the web section to the normal speed.

2. A method as recited in Claim 1, characterized in that, before reaching sensor (5), the paper web passes an additional sensor and that the additional sensor performs a preliminary or rough determination of the paper defect, whereas sensor (5) is designed for additional determination of the nature of the paper defect, e.g., its type and shape.

3. A method as recited in Claim 2, characterized in that the time at which the predetected web section with the paper defect will reach sensor (5) is calculated, based on the speed of paper web (4) on its way to sensor (5).

4. A method as recited in Claim 3, characterized in that the speed of the web section with the paper defect is reduced to a value less than the normal speed even before arrival of the web section at sensor (5).

5. A method as recited in Claim 4, characterized in that the already reduced speed can be reduced to an even lower value or to zero immediately before the web section reaches station (6) for defect elimination.

6. A method as recited in one of the previous Claims, characterized in that the paper defect is eliminated by covering the defective space with a quick-hardening fluid, thereby forming a flat covering.

7. A method as recited in Claim 6, characterized in that the fluid is sprayed onto the defective area on one or both sides.

8. A method as recited in Claim 6, characterized in that the fluid is applied to the defective area by rollers.

9. A method as recited in Claim 6, 7, or 8, characterized by the use of a quick-hardening UV lacquer as the fluid.

10. A method as recited in one of the previous Claims, characterized in that station, sensor, and additional sensor are arranged along a continuous paper web (on-line method) and that paper defects are automatically eliminated at full paper web speed in the paper machine.

11. A method as recited in one of the previous Claims, characterized in that the additional sensor is arranged on a paper machine and that station (6) and sensor (5) are arranged along a take-up roll or preroller located after the paper machine (off-line method).

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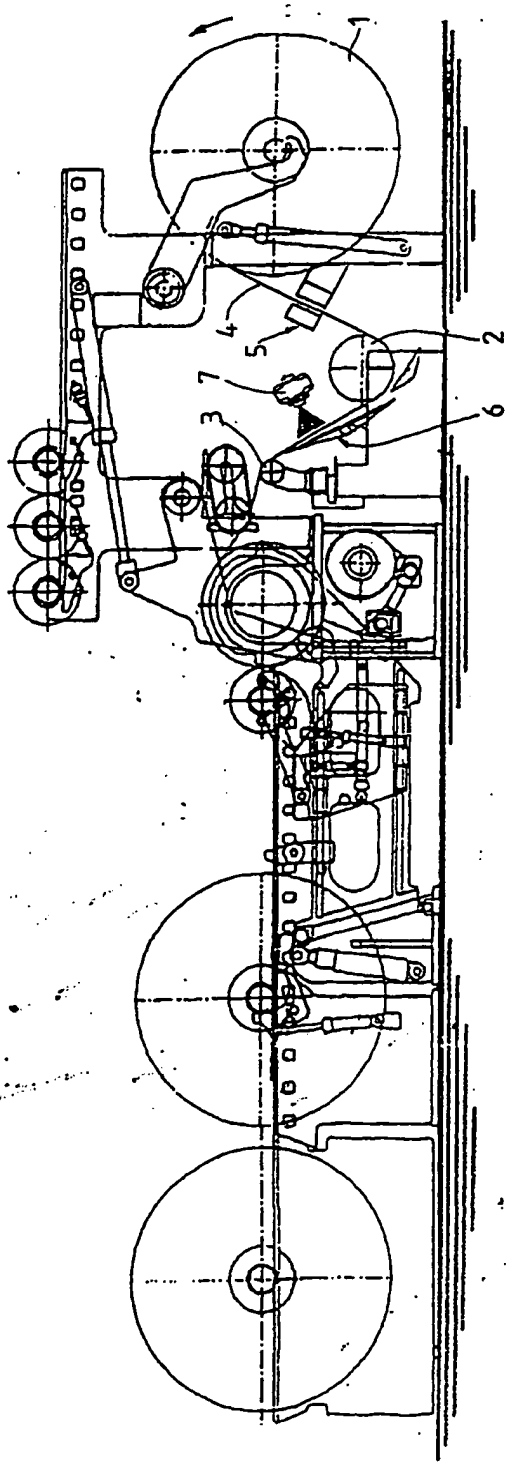
1 page of figure attached.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